SYSTEM AND METHOD FOR FRAME SELECTION IN IP-BASED CDMA NETWORK

I. Field Of The Invention

[0001] The present invention relates generally to enabling a wireless telephone that is not required or generally configured to support voice over Internet Protocols (VOIP) to nonetheless communicate with wireless telephone infrastructure that uses IP structures or architectures, with IP-based communication between the wireless telephone infrastructure and any VOIP-based infrastructure being supported.

II. Background Of The Invention

[0002] Wireless telephones, such as but not limited to wireless telephones that communicate using Code Division Multiple Access (CDMA) spread spectrum modulation techniques, communicate over the air with system infrastructure using wireless telephone over-the-air communication protocols, e.g., the CDMA protocols known as IS-95A, IS-95B, and IS-2000. The system infrastructure, which can include base stations (BTS), base station controllers (BSC), and other components, connects the wireless telephone to another communication device, such as a through land line or another wireless communication system.

[0003] In the case of CDMA, voice data is sent over the air in packets that are collected by the infrastructure and assembled into a voice stream, transparently to the speakers who are talking to each other. As might be expected, the over-the-air protocol is tailored to optimize wireless communication. For instance, to maximize over-the-air capacity, the over-the-air protocol contains a minimum of signalling information, and the size of a voice data packet is relatively small.

[0004] With the growth of the Internet, computer-to-computer communication using Internet Protocols (IP) has become ubiquitous. Furthermore, it has become desirable not only to facilitate computer data communication using IP, but to facilitate voice communication using IP as well. As but one advantage afforded by using IP in a telephony infrastructure, much hardware such as switches can be eliminated, and existing computers and software can be used instead, reducing cost. To this end, so-called voice over IP (VOIP) has been introduced.

[0005] To support VOIP, a communication device must have, among other requirements, IP capability, i.e., the device must itself be able to communicate using IP, and it must have an IP address.

[0006] The present invention critically observes, however, that requiring a wireless telephone to use VOIP diminishes over-the-air capacity because VOIP is not necessarily designed to maximize such capacity. Instead, VOIP accounts for design considerations that are not necessarily related to wireless telephony. As an example, the data packet size of VOIP is relatively large, compared to the packet size used throughout the wireless communication industry such as in wireless telephones using over-the-air protocols such as IS-95. Indeed, a typical packet size in the IS-95 protocol is less than the size of a single packet header employed in a typical IP. Moreover, configuring a wireless telephone to communicate using both IP and over-the-air protocols complicates telephone design, adversely strains available resources (e.g., power, computing cycles, coding, and so on), and increases costs.

[0007] Nonetheless, the present invention understands that it would be desirable to enable wireless telephone communication using an infrastructure that transmits data in accordance with IP principles. With the above considerations in mind, the present invention provides the solutions disclosed below.

SUMMARY OF THE INVENTION

[0008] A voice over Internet (VOIP) system includes plural access points communicating with wireless communication devices using a wireless communication device over-the-air protocol that is different from Internet protocol (IP). Each wireless communication device transmits frames of information, and a first access point undertakes frame selection for a first communication device. A second access point assumes frame selection for the first communication device when a predetermined threshold is reached.

[0009] In a preferred embodiment, the wireless communication device protocol is a code division multiple access (CDMA) protocol, and each first and second access point is a respective first and second CDMA access point (CAP). In a particularly preferred, non-limiting embodiment, the access point is a base station (BTS), enhanced with the logic described herein, and the infrastructure need not include a base station controller (BSC).

[0010] As set forth in greater detail below, the preferred implementation distributes a selector functionality over the CAPs. The functionality that is distributed over the CAPs can be thought of as a selector entity that receives first communication device frames from the first CAP when a first threshold is reached, and monitors frame selection by the first CAP for the first communication device. Moreover, a selector entity assumes frame selection for the first communication device when a second threshold is reached. At this point, the second CAP proposes frame selections for the first communication device and forwards the frame selections to the selector entity for monitoring thereby. When the selector entity determines that frame selections from the second CAP are within a predetermined correctness threshold, the selector entity causes the second CAP to assume frame selection for the first communication device.

[0011] In another aspect, a method for frame selection in a wireless communication device infrastructure includes establishing communication between at least a first base station (BTS) and at least one wireless communication device using a non-Internet protocol (IP) over-the-air (OTA) protocol. The first base station is one of a plurality of base stations in an infrastructure. The method includes selecting frames from the wireless communication device at the first base station (BTS), and then selecting frames from the wireless communication device at a second base station (BTS).

[0012] In still another aspect, a computer program product includes logic means for dynamically establishing a selector base station (BTS) in a wireless telephony infrastructure that uses IP. Logic means establish CDMA over-the-air communication between at least one base station in the

infrastructure and a CDMA wireless communication device. Also, logic means hand off the selecting of frames of information from the communication device from the selector base station to a substitute base station upon reaching a threshold.

[0013] In another aspect, a communication system includes at least two wireless endpoints configured for CDMA communication with a wireless communication device. The endpoints communicate with each other using IP. At least a first one of the endpoints is dynamically selected as a selector endpoint that undertakes a frame selection service for the wireless communication device and that undertakes handoff assistance for transferring frame selection from the selector endpoint to a substitute endpoint in accordance with a handoff algorithm.

[0014] In yet another aspect, a voice over Internet (VOIP) system includes plural access points communicating with plural wireless communication devices using a wireless communication device over-the-air protocol that is different from Internet protocol (IP). Each wireless communication device transmits frames of information, and at least one access point undertakes frame selection, including the addition and subtraction of access point sectors to a call.

[0015] The details of the present invention, both as to its structure and operation, can best be understood in reference to the accompanying drawings, in which like reference numerals refer to like parts, and in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] Figure 1 is a block diagram of one preferred implementation of the wireless telephone system of the present invention;

[0017] Figure 2 is a flow chart of the logic for frame selection at one of the CDMA Access Points (CAP) of the present invention; and

[0018] Figure 3 is a flow chart of the logic for handing off frame selection between CDMA access points (CAPs).

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0019] Referring initially to Figure 1, a system is shown, generally designated 10, for effecting communication between a target wireless communication device 12 such as but not limited to a telephone that does not support Internet Protocol (IP) and a telephony infrastructure 14 that does support IP. This invention is directed to distributing the frame selection and handoff functionality of a selector entity among plural base stations.

[0020] By "does not support VOIP" or "does not support IP" is meant that the device 12 either has no IP or VOIP capability, or that it has such capability but for improved performance uses a standard over the air (OTA) protocol such as a spread spectrum scheme like CDMA or WCDMA or other wireless protocol such as but not limited to TDMA, UMTS, TD-SCDMA, etc. to communicate with the infrastructure 14. In one non-limiting embodiment the device 12 is a mobile telephone made by Kyocera, Samsung, or other manufacturer that uses Code Division Multiple Access (CDMA) principles and CDMA over-the-air (OTA) communication air interface and includes protocols such as defined in but not limited IS-95A, IS-95B, UCDMA, IS-2000, and others to communicate with the infrastructure 14.

[0021] For instance, the wireless communication systems to which the present invention can apply, in amplification to those noted above, include Personal Communications Service (PCS) and cellular systems, such as Analog Advanced Mobile Phone System (AMPS) and the following digital systems: CDMA, Time Division Multiple Access (TDMA), and hybrid systems that use both TDMA and CDMA technologies. A CDMA cellular system is described in the Telecommunications Industry Association/Electronic Industries Association (TIA/EIA) Standard IS-95. Combined AMPS and CDMA systems are described in TIA/EIA Standard IS-98. Other communications systems are described in the International Mobile Telecommunications System 2000/Universal Mobile Telecommunications Systems (IMT-2000/UM), standards covering what are referred to as wideband CDMA (WCDMA), cdma2000 (such as cdma2000 1x or 3x standards, for example) or TD-SCDMA.

[0022] The present invention applies to any wireless communication device 12; for illustration it will be assumed that the device 12 is a telephone 12. In general, wireless communication devices to which the present invention applies may include but are not limited to a wireless handset or telephone, a cellular phone, a data transceiver, or a paging and position determination receiver, and can be hand-held, or portable as in vehicle-mounted (including cars, trucks, boats, planes, trains), as desired. However, while wireless communication devices are generally viewed as being mobile, it

is to be understood that the present invention can be applied to "fixed" units in some implementations. Also, the present invention applies to data modules or modems used to transfer voice and/or data information including digitized video information, and may communicate with other devices using wired or wireless links. Further, commands might be used to cause modems or modules to work in a predetermined coordinated or associated manner to transfer information over multiple communication channels. Wireless communication devices are also sometimes referred to as user terminals, mobile stations, mobile units, subscriber units, mobile radios or radiotelephones, wireless units, or simply as "users" and "mobiles" in some communication systems.

[0023] As shown in Figure 1, the wireless telephone 12 communicates with at least one first infrastructure component 16. The first component 16 is a code division multiple access (CDMA) access point (CAP), and preferably is a base station (BTS). As intended herein, the BTS does not communicate with a base station controller (BSC) that is external to the BTS, i.e., the infrastructure 14 does not contain a BSC. Less desirably, a BSC can be included in the infrastructure, but with the below-disclosed frame selection function being undertaken by a BTS.

[0024] A second CAP 18 is also established by a BTS of the infrastructure 14. While for clarity of disclosure Figure 1 shows only two CAP 16, 18, it is to be understood that more than two CAPs can be incorporated into the system 10. In any case, the functions of frame selection and handoff control are distributed among the CAP 16, 18.

[0025] In the presently preferred embodiment, communication within the infrastructure 14 is via Internet Protocol (IP). The CAPs 16, 18 thus communicate with wireless telephones 12 using OTA protocol, preferably using CDMA, but communicate internally to the infrastructure 14 using IP, thereby relieving the wireless telephone 12 from having to support IP. Also, by using IP internally to the infrastructure 14 and OTA protocol to the telephone 12, the advantages of using IP internal to the infrastructure 14 are realized, whereas the advantages of OTA protocol in wireless communication to the telephone 12 are preserved to maximize the over-the-air capacity of the system 10. Accordingly, the CAPs 16, 18 can be thought of as virtual IP endpoints, with the actual communication endpoint being the telephone 12.

[0026] Figure 1 further shows that the target wireless telephone 12 can also communicate with communication devices outside the infrastructure 14. Specifically, the infrastructure 14 can include a VOIP gateway for communicating, in accordance with principles known in the art, with a public switch telephone network (PSTN) 20. The communication between the VOIP gateway and the PSTN 20 can be via a signalling protocol such as ISUP using a physical system such as SS7. In turn, the

PSTN includes one or more landline devices such as telephones or modems, to complete the communication pathway between the target wireless telephone 12 and the landline devices.

[0027] Additionally, the target wireless telephone 12 can communicate with the Internet 22, including Internet-based communication devices such as personal computers (PC) or other computers, via the infrastructure 14. Still further, the infrastructure 14 can communicate with wireless telephone systems 24 that are outside the infrastructure 14. Communication between the infrastructure 14 and the other wireless/cellular systems 24 can be via IS-41 protocol or IP.

[0028] With the above overview of the present architecture in mind, it is to be understood that the present logic is executed on the architecture shown in Figure 1 in accordance with the flow chart discussed below. The flow charts herein illustrate the structure of the logic of the present invention as embodied in computer program software. Those skilled in the art will appreciate that the flow charts illustrate the structures of logic elements, such as computer program code elements or electronic logic circuits, that function according to this invention. Manifestly, the invention is practiced in its essential embodiment by a machine component that renders the logic elements in a form that instructs a digital processing apparatus (that is, a computer) to perform a sequence of function steps corresponding to those shown.

[0029] In other words, the logic may be embodied by a computer program that is executed by a processor within, e.g., the CAPs 16 and/or 18 as a series of computer-executable instructions. These instructions may reside, for example, in RAM or on a hard drive or optical drive, or the instructions may be stored on magnetic tape, electronic read-only memory, or other appropriate data storage device.

[0030] Now referring to Figure 2, the logic of the present invention in selecting frames is shown. Commencing at step 26, once communication using an appropriate over-the-air (OTA) protocol is established between the telephone 12 and the first CAP 16, i.e., between the telephone 12 and the virtual IP endpoint of the present invention, the CAPs 16, 18 negotiate among themselves or otherwise establish which CAP will initially function as the frame selector CAP. That is, the CAPs can determine which one will have frame selecting responsibility for the telephone 12 when the telephone 12 logs into the infrastructure 14. Frame selection also controls the addition of base station/CAP sectors to a call as a mobile device 12 moves. Moreover, the frame selection CAP can assume the below-described handoff function, or less preferably another CAP can be assigned that function.

[0031] For instance, when the pilot signal is received from the telephone 12 by only a single CAP, that CAP assumes frame selection responsibility for the telephone, and informs the infrastructure 14 of this. On the other hand, when two or more CAPs initially detect the telephone 12, the CAPs can use a negotiation protocol to determine which CAP will undertake frame selection. In one non-limiting embodiment used for illustration, the negotiation protocol can include designating the CAP initially receiving the strongest signal from the telephone 12 as the frame selector for the telephone 12. Determining a frame selector CAP can thus be done dynamically as the telephone 12 logs into the infrastructure 14.

[0032] In any case, when a wireless device 12 establishes communication with a selector CAP, the selector CAP assigns the device 12 a temporary IP address for all call setup functions involving other communication endpoints. When an endpoint requests a resource from an additional CAP or is handed off thereto, the selector CAP associates a second IP address (such as an IP-port number pair), and disseminates this second IP address to the candidate CAP only. All IP packets from the endpoint arriving at the candidate CAP are delivered to the second IP address, while all call setup requests are delivered to the selector CAP. Additional CAP can be treated similarly. The above-described multi-address feature supports frame selection and handoff described below.

[0033] Proceeding to step 28, the selector CAP directs other CAPs in the infrastructure 14 to forward all reverse-link frames (i.e., frames representing information transmitted by the telephone 12) to the selector CAP. At step 29, the selector CAP undertakes frame selection in accordance with frame selection principles known in the art to select the "best" frame from the various CAPs to be the frame for the call. Moreover, at step 30 the selector CAP sends forward link frames (i.e., frames intended for the telephone 12) to all CAPs (i.e., to all BTS) that are participating in the call, for transmission thereof to the telephone 12.

[0034] In the preferred IP implementation of the infrastructure 14, when communication is established, OTA packets such as OTA voice packets from the wireless telephone 12 are transformed or otherwise converted to IP at the virtual IP endpoints, i.e., at the CAPs 16, 18, etc. that are participating in the call. To make this transformation, the contents of the OTA voice packets are rearranged as appropriate to conform to IP packet requirements. The information in IP is sent through the infrastructure 14 toward the recipient.

[0035] Likewise, IP packets representing information intended for the telephone 12 move through the infrastructure 14 and are converted to OTA packets by the virtual IP endpoints (CAPs). The OTA packets are sent to the telephone 12. The transformation from IP to OTA protocol is the

reverse of the process for converting OTA packets to IP packets, i.e., each IP packet might be separated into a set of smaller OTA packets as appropriate to conform to the OTA protocol used by the telephone 12.

[0036] The present invention recognizes that it might be desirable to hand off the frame selection process between CAPs as the telephone moves between CAPs. The present invention further recognizes that it would be desirable to reduce "dropped" calls as frame selection is handed off between CAPs. With these critical observations in mind, attention is now drawn to the logic flow chart of Figure 3.

[0037] Commencing at step 40, the first CAP 16 is initially selected as a frame selector CAP for the wireless telephone 12. The first CAP 16 can be the first BTS of the infrastructure 14 that detects the wireless telephone 12. The first CAP 16 performs frame selection in accordance with CDMA frame selection principles known in the art.

[0038] Moving to decision diamond 42, it is determined whether a first threshold is reached. In one non-limiting exemplary embodiment, the first threshold can be a predetermined pilot channel signal strength provided from the telephone 12 and indicating a signal strength from the second CAP 18. Or, the first threshold can be a predetermined pilot channel signal strength provided from the second CAP 18 and indicating a signal strength from the telephone 12. Or yet again, the first threshold can be another type of signal strength or other network parameter.

[0039] When the first threshold is reached, the process proceeds to step 44, wherein the first CAP 16 continues frame selection, and also forwards both all frames received and "best" frame selections to a selector entity, which can be a software or hardware-implemented entity at the selector CAP or other CAP. That is, the handoff functionality of a selector entity, formerly centralized at a base station controller (BSC), is distributed among the CAP in the present invention. Thus, the "selector entity" referred to herein is implemented by one or more CAP, and indeed the functionality of the selector entity can move from CAP to CAP just as frame selection is distributed.

[0040] The selector entity can be incorporated anywhere in the infrastructure 14, and can be implemented by hardware or software. In any case, the selector entity, at step 46, informs the second CAP 18 to send its frames from the telephone 12 to the selector entity, instead of to the first CAP 16. The second CAP 18 makes this change simply by changing the IP address of the frames to match the IP address of the selector entity. The selector entity can then relay the frames to the first CAP 16 to support continued frame selection at the first CAP 16, while simultaneously monitoring frame selection as reported back by the first CAP 16.

[0041] The process then monitors for the occurrence of a second threshold. this step of the process is indicated at decision diamond 48 in Figure 3. The second threshold can be, e.g., a higher predetermined pilot channel strength than the first threshold. When the second threshold is reached, the selector entity assumes frame selection and halts the frame selection process by the first CAP 16 at step 50. Moreover, the selector entity informs the second CAP 18 to propose "best" frame selections while continuing to forward frames to the selector entity, and the selector entity monitors the proposed frame selections from the second CAP 18.

[0042] When the propose frame selections are "correct" within a predetermined correctness threshold, as indicated at decision diamond 52, the selector entity causes the second CAP 18 to assume frame selection at step 54. The selector entity then halts its own frame selection and relieves the second CAP 18 from forwarding frames to the selector entity. The above logic essentially effects a "soft" handoff of the frame selection function from the first CAP 16 to the second CAP 18, thereby reducing the likelihood of dropped calls as the telephone moves between the CAPs 16, 18.

[0043] While the particular SYSTEM AND METHOD FOR FRAME SELECTION IN IP-BASED CDMA NETWORK as herein shown and described in detail is fully capable of attaining the above-described objects of the invention, it is to be understood that it is the presently preferred embodiment of the present invention and is thus representative of the subject matter which is broadly contemplated by the present invention, that the scope of the present invention fully encompasses other embodiments which may become obvious to those skilled in the art, and that the scope of the present invention is accordingly to be limited by nothing other than the appended claims, in which reference to an element in the singular is not intended to mean "one and only one" unless explicitly so stated, but rather "one or more". All structural and functional equivalents to the elements of the above-described preferred embodiment that are known or later come to be known to those of ordinary skill in the art are expressly incorporated herein by reference and are intended to be encompassed by the present claims. Moreover, it is not necessary for a device or method to address each and every problem sought to be solved by the present invention, for it to be encompassed by the present claims. Furthermore, no element, component, or method step in the present disclosure is intended to be dedicated to the public regardless of whether the element, component, or method step is explicitly recited in the claims. No claim element herein is to be construed under the provisions of 35 U.S.C. §112, sixth paragraph, unless the element is expressly recited using the phrase "means for" or, in the case of a method claim, the element is recited as a "step" instead of an "act".

WE CLAIM: